Score: ____
35

Your name _____

Student ID # _____

Biology 5A (Section 001, Fall, 2014)
October 27, 2014
Midterm Examination #1
Version A

You may **NOT** talk, pass notes, or have any books, notes, calculators, earphones, or electronic communications devices near you during the examination. Bathroom breaks are not allowed. Be sure your exam has the number of questions shown on the top left of this page.

On this exam copy, write your name and student ID#, and circle your Discussion TA's name and start time. In the appropriate space on the Scantron form, fill in your name, student ID#, and exam version number (shown above), and bubble in the corresponding circles.

For each question, choose only ONE answer that is the BEST of all the choices, and the most consistent with what was presented either in the lecture or in any notes that your instructor(s) distributed to the class. When you are done, slide the Scantron form under the first page, and turn both in together.

When you finish, please check that your Scantron form is correctly marked and is consistent with your answers on this examination copy, and that you have answered all questions.

There is a zero-tolerance policy for academic misconduct as stated in the Biology 5LA laboratory manual.

H 1							**He 2**
Li 3	**Be 4**	**B 5**	**C 6**	**N 7**	**O 8**	**F 9**	**Ne 10**
Na 11	**Mg 12**	**Al 13**	**Si 14**	**P 15**	**S 16**	**Cl 17**	**Ar 18**

Of n=254 students, the average score was 18.8/35 (54%) with a range of 3/35 (9%) – 33/35 (94%).

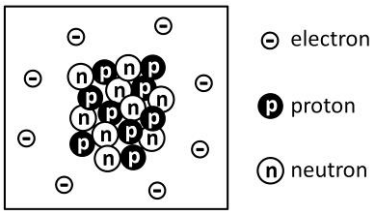
Answer key:

1	C	6	C	11	D	16	B	21	E	26	D	31	D
2	A	7	E	12	E	17	B	22	C	27	A	32	D
3	B	8	B	13	A	18	A	23	A	28	D	33	E
4	E	9	D	14	B	19	D	24	C	29	C	34	C
5	E	10	B	15	C	20	A	25	C	30	B	35	B

1) According to the modern version of the Cell Theory, all cells:
   A) Transmit energy to other cells.
   B) Store their genetic material as DNA.
   C) Are composed of similar molecules.
   D) Change (evolve) over time.
   E) Use oxygen and give off carbon dioxide.

2) If an atom has different numbers of _____ and _____, it must be _____:
   A) electrons, protons, an ion
   B) protons, electrons, radioactive
   C) protons, neutrons, radioactive
   D) neutrons, electrons, an ion
   E) More than one of the above are correct.

Use the atom shown here to answer the next <u>two</u> questions. (There is a periodic table on the front page of the exam.)



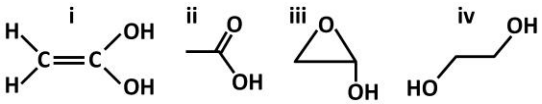
3) The overall charge of the atom is ____ and there are ____ electrons in the outermost electron shell:
   A) -8, 2 B) +1, 6 C) -1, 8 D) 0 (neutral), 8 E) +9, 6

4) If one of the protons decays into a neutron, the element that results will be:
   A) ^{19}Ne B) ^{18}F C) ^{19}F D) ^{17}O E) ^{18}O

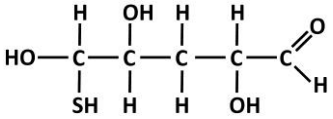
5) Adding an acid to pure water will:
   I. Reduce the pH II. Change the product of [OH-]x[H+] III. Increase the ratio of [H+] to [OH-]
   A) I only. B) I, II, III. C) I and II. D) II and III. E) I and III.

6) In the Miller-Urey experiment, atoms of simple molecules (H_2O, NH_3, CH_4 and H_2) were allowed to combine together to form other molecules. Which of the following types of molecules would *not* be able to be made?
   A) Sugars. B) Fatty acids. C) Nucleotides. D) Amino acids. E) Nucleosides.

7) Which of the following molecules are structural isomers of each other?
   A) i, iii
   B) i, ii
   C) iii, iv
   D) ii, iii, iv
   E) i, ii, iii

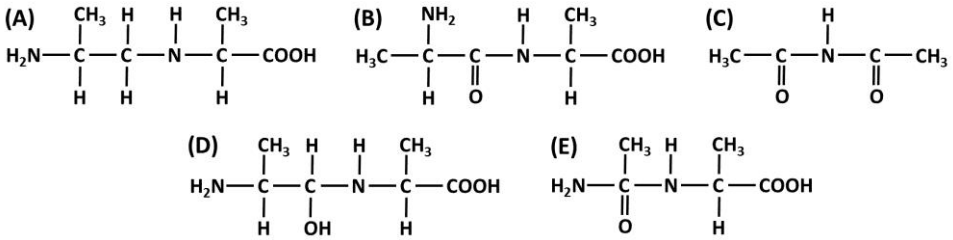


8) How many asymmetric carbons are in the molecule shown below?
   A) 0
   B) 3
   C) 4
   D) 1
   E) 2

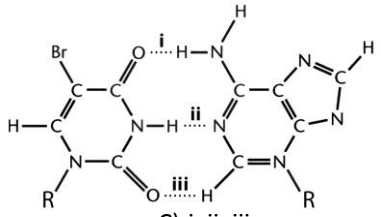


9) In the molecule in the question above, all of the following functional groups occur <u>except</u>:
   A) carbonyl B) hydroxyl C) sulfhydryl D) carboxyl E) All these occur.

10) The side chain of the amino acid alanine is a methyl group. Which of these shows a correct structure of a dipeptide consisting of two alanines?



11) Shown below are possible interactions between two molecules. Which of i, ii and iii represent(s) a hydrogen bond?



A) iii only B) i, iii C) i, ii, iii D) i, ii E) i only

12) If five of the sugar $C_3H_6O_3$ become joined together by dehydration reactions, the resulting polysaccharide will have the chemical formula:
A) $C_{15}H_{18}O_9$ B) $C_{15}H_{38}O_{19}$ C) $C_{15}H_{30}O_{15}$ D) $C_{15}H_{20}O_{10}$ E) $C_{15}H_{22}O_{11}$

13) Polymers of six-carbon sugars are found in all of the following except:
A) The backbone of polynucleotide chains.
B) Major component of plant cell walls.
C) Storage polysaccharides in plants.
D) Storage of chemical energy in the liver.
E) Insect exoskeleton (with slight modification).

14) A saturated fatty acid will not dissolve in water because:
A) A strong network of hydrogen bonds occurs among fatty acid molecules.
B) Most bonds between the atoms involve equal sharing of electrons.
C) Saturated fatty acids are highly likely to be solid at room temperature.
D) The lack of double bonds prevents interaction of the carbon atoms with water.
E) There are no polar functional groups present in a fatty acid.

15) A correct match between the macromolecule and the type of covalent bond between monomers is:
A) triglyceride; phosphodiester.
B) nucleotide; peptide.
C) sugar; glycosidic.
D) lipid; van der Waals.
E) amino acid; ionic.

16) In the linear form of every monosaccharide:
A) Double bonds are found between some carbon atoms (in plants only).
B) Every carbon atom is covalently bonded to one oxygen atom.
C) The first (or last) carbon atom is double-bonded to an oxygen atom.
D) The chemical formula differs from $C_n(H_2O)_n$ compared to the ring form.
E) All of the above are correct.

17) A single-stranded RNA molecule of sequence 5'-AAAAAAA-3' is treated with an enzyme that hydrolyzes the bonds between the adenines and the sugar groups. What is left?
A) Free sugars and phosphates, with all the adenines joined in a chain.
B) Free adenines, and an intact chain of sugars and phosphates.
C) Free sugars, and adenines joined to phosphates.
D) Free phosphates, sugars and adenines.
E) The molecule would still be intact.

18) The most complex type of macromolecule is:
A) Protein. B) Lipid. C) RNA. D) Glycogen. E) DNA.

19) Which is correct about macromolecules as discussed in class?
A) A gene determines the arrangement of monomers in glycogen.
B) Individual carbohydrates like glucose are made by a gene.
C) DNA is directly translated to produce polypeptides.
D) Every enzyme corresponds to part of a chromosome.
E) Cells make proteins by copying other polypeptides.

20) All of these are functions of proteins in cells except:
A) Carrying information from genes to the cytosol.
B) Circulating as hormones in the human bloodstream.
C) Functioning as catalysis to digest polysaccharides.
D) Forming part of the structure of ribosomes.
E) Helping ions move across lipid bilayers inside cells.

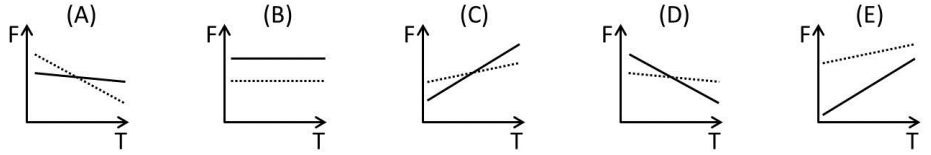
21) During the hydrogenation of fats that are isolated from plants:
A) The fats will end up with a lower molecular mass.
B) C-C single bonds are converted to C=C double bonds.
C) The hydrocarbon chains will become less hydrophobic.
D) The fatty acid tails will become more kinked.
E) Unhealthy trans fats can be made as a byproduct.

22) The human digestive enzyme pepsin is most active a pH 2 and a temperature between 37°C and 42°C. It does not work outside of these conditions because ____ structure become(s) affected.
A) 2° B) 1° C) 2° and 3° D) 1°, 2° and 3° E) 3°

23) A DNA strand is properly base paired with an RNA strand. If the DNA is 5'-ATGGAC-3', the RNA must be:
A) 5'-GUCCAU-3' B) 3'-GTCCAT-5' C) 5'-AUGGAC-3' D) 5'-UACCUG-3' E) 5'-CAGGUA-3'

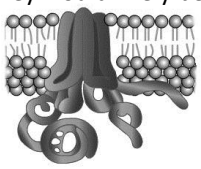
24) An amino acid with side chain $-CH_2-CH_2-CH_2-CH_2-NH_2$ is classified as:
A) Acidic. B) Nonpolar. C) Basic. D) Polar. E) None of these.

25) The following graph correctly relates membrane fluidity (F) with temperature (T), in the absence (—) and presence (····) of cholesterol in the membrane:



26) Small particles and liquids are taken into cells by:
A) Plasmolysis. B) Phagocytosis. C) Autophagy. D) Pinocytosis. E) Exocytosis.

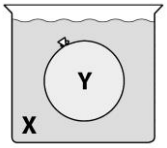
27) If you compared the 1° structure of the CFTR receptors between two healthy, unrelated humans, they would likely be:
A) identical or almost identical.
B) between 10%-50% identical.
C) approximately 5% identical.
D) a completely different shape.
E) None of these; only cystic fibrosis patients make this protein.



28) Which is correct about gene expression in prokaryotes and/or eukaryotes?
A) In eukaryotes, transcription and translation are coupled in the nucleus.
B) In eukaryotes, translation is nuclear and transcription is cytoplasmic.
C) Prokaryotes require transcription and translation to occur separately.
D) Transcription and translation can occur together in a prokaryote cell.
E) Transcription and translation both occur in the cytoplasm of eukaryotes.

29) The best evidence that chloroplasts used to live outside of cells is that they:
A) Are enclosed by a membrane.
B) Have enzymes for metabolism.
C) Have their own chromosome.
D) Are primarily found in plants.
E) Contain simple carbohydrates.

30) A "cell" enclosed in a semi-permeable membrane is placed in a beaker. The membrane is permeable to only water. The cell (Y) contains 0.05 M aluminum chloride ($AlCl_3$), while the solution in the beaker (X) consists of 0.1 M sodium chloride (NaCl). Assume both solutes are completely dissolved. Over time, the cell will:
A) Shrink. B) Stay the same size. C) Expand.

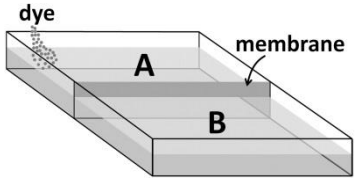


31) Ribosomes (or ribosomal subunits) can be found in all these locations in a plant cell, except:
A) Nucleolus. B) ER. C) Mitochondria. D) Golgi. E) Cytoplasm.

32) In a eukaryotic cell, a membrane encloses a region of low pH containing enzymes that break down macromolecules. This structure is:
A) The Golgi. B) Smooth ER. C) A vacuole. D) A lysosome. E) Rough ER.

33) 10g of a water-soluble dye are added to one side of a tank of water containing a membrane that is permeable to both the dye and water. After several hours, the dye is present in equal amounts on both sides A and B. The process that causes this to occur can be called _____ and at equilibrium, the dye molecules _____ moving across the membrane.

A) active transport; continue
B) passive transport; stop
C) osmosis; stop
D) facilitated diffusion; stop
E) diffusion; continue



34) The different types of fibers that make up the cytoskeleton are all made of:
A) Polymers of glucose.
B) Modified phospholipids.
C) Protein subunits.
D) Polymers of chitin.
E) Long-chain fatty acids.

35) Which of the following correctly follows the synthesis of insulin in pancreatic islet cells (not all steps are shown)?
A) insulin gene -> translation in Golgi apparatus -> vesicles -> bloodstream
B) messenger RNA -> rough ER -> Golgi apparatus -> vesicles
C) glucose -> dehydration by enzyme -> lysosomes -> bloodstream
D) transcription -> smooth ER -> vesicles -> Golgi apparatus
E) glycogen -> hydrolysis by enzymes -> vesicles -> bloodstream

Biology 5A – Summer, 2014
Dr. M. Maduro · *Figures are from the textbook (Campbell et al.) and other sources.*
Gene Expression: Transcription, Genetic Code • *Biology*, 10th ed.: pp. 333-344.

Learning Goals

- Explain how Beadle and Tatum were able to conclude that the steps in a biosynthetic pathway are controlled by enzymes, each of which is the product of a particular gene.
- Predict growth phenotypes of biosynthesis pathway mutants on various media.
- Explain the process of transcription of a gene into a messenger RNA (mRNA), and how the process is different in eukaryotes *vs.* prokaryotes.
- Explain how expression of different genes is controlled.
- Read a genetic code table and describe the roles of the special codons during translation.
- Describe how the linear sequence of bases in a messenger RNA corresponds to the primary structure of a polypeptide.

Terms you will need to know: wild-type, mutant, mutagenic, mutation, heritable, minimal medium (MM), transcription, translation, messenger RNA (mRNA), intron, promoter, transcription factor, RNA polymerase, ribosome, terminator, intron, splicing, 5'cap, polyA tail, translation, codon, degeneracy, start codon, stop codon, nonsense codon

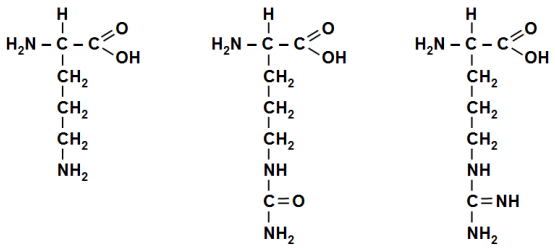
What is a gene?

Genes are units of heredity: They are passed from generation to generation and are carried on chromosomes. Each gene provides an organism with some type of function. As we have seen, genes can be present in a population in different forms called alleles. Changes in the genetic material, called mutations, affect how genes function, and mutations can be passed on from one generation to the next. As we will see, genes are segments of DNA within a chromosome that allow a particular polypeptide to be made. An earlier version of this idea was the 'one gene – one enzyme' hypothesis advanced by Beadle and Tatum.

Beadle and Tatum (1941) worked with the bread mold *Neurospora*. This mold spends much of its life as a haploid. *Wild-type* (normal) *Neurospora* can grow on a simple growth medium called **minimal medium (MM)** that contains agar, salts, glucose and biotin (a vitamin). Beadle and Tatum treated *Neurospora* with X-rays, which are *mutagenic*: X-rays cause damage to DNA, resulting in a loss of genetic information in random places throughout the genome. They then looked for *mutants* that were unable to grow on minimal media, but which could grow on a medium that was supplemented with all 20 essential amino acids ('complete medium').

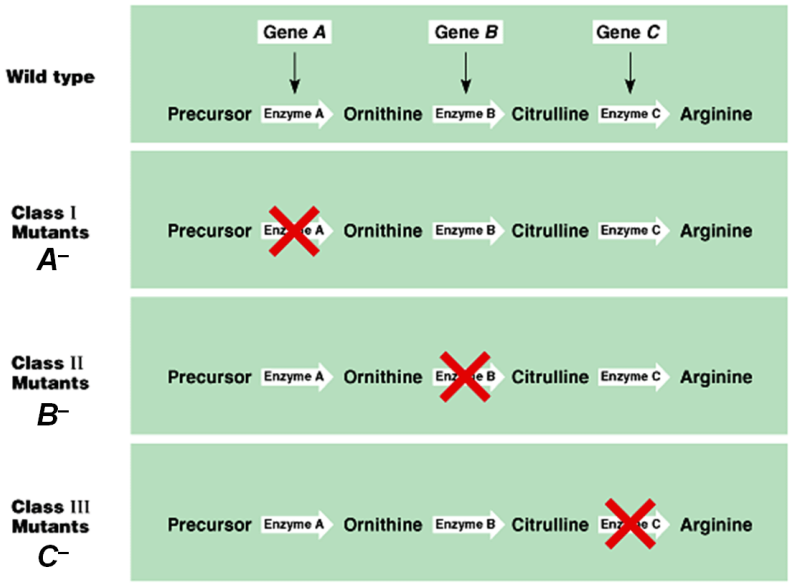
They found mutants that were unable to grow on MM, but were able to grow on MM + arginine. Hence, these mutants had a specific inability to make arginine: They could convert the precursors in MM to 19 of the 20 essential amino acids, just not arginine.

Beadle and Tatum hypothesized that the mutants that could not make arginine might fail to do so because they were unable to change related molecules into arginine. They tested the ability of these mutants to grow on MM + related amino acids as shown at right.



They found that their mutants fell into different classes: Those that could be rescued (i.e. made able to grow on MM) by any of the three amino acids, those that could be

rescued only by citrulline or arginine, and those that would grow only if the minimal medium was supplemented with arginine.



Beadle and Tatum concluded that arginine is synthesized in a series of discrete steps, and that each step is catalyzed by an enzyme – the product of a gene. Each class of mutant is therefore unable to make one of these enzymes because it carries a mutation in the gene that is responsible for making that enzyme.

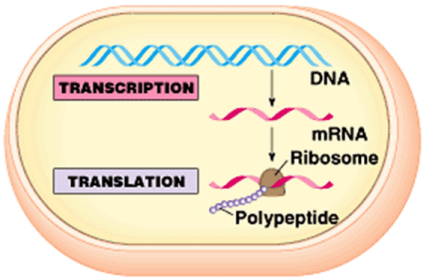
If minimal medium is supplemented with a chemical that is after the block in the pathway, then the *Neurospora* mutant will be able to grow, because it now has arginine (or can make it).

Note that a given *Neurospora* mutant strain will not be genetically "cured" by the supplements in the medium although the cells can grow. Unless another mutation reverses the genetic damage, these strains will always be unable to produce a particular enzyme. For example, a *B*- strain will always be unable to produce the enzyme that converts ornithine to citrulline. The defect is in the DNA and is therefore passed from one generation to the next. The presence of citrulline or arginine in the medium can compensate for the defect but not "cure" it. (This is an example of the relationship: Genotype + Environment = Phenotype.)

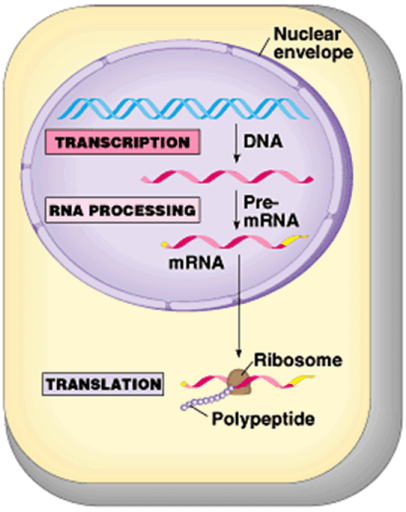
The Central Dogma: DNA → RNA → protein.

In modern terms, a gene contains the information that allows for the synthesis of a particular polypeptide. Two decades after the work of Beadle and Tatum, the process by which a gene generates its product, a short-lived intermediate called *messenger RNA*, was discovered. The information in the messenger RNA, generated during *transcription*, is converted into an amino acid sequence during *translation.*

In prokaryotes, transcription and translation are *coupled* – an mRNA that is not yet completely made can begin to be translated by ribosomes. In eukaryotes, mRNAs must be transported out of the nucleus to be translated. As well, in eukaryotes messenger RNAs often contain introns, which are removed (by a set of enzymes); the 5' end is modified by covalent addition of a Cap (a guanine nucleotide), and addition of multiple A bases (tens to hundreds) to the 3' end by another enzyme (PolyA polymerase). The modified ends function in nuclear export of the mRNA, protection of the ends of the molecule from enzymes, and in promoting translation.

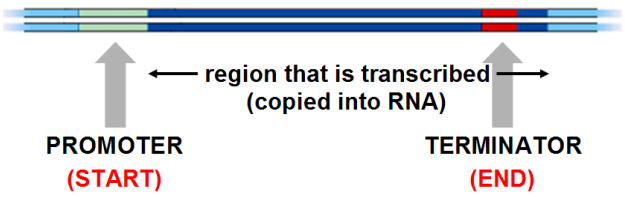


prokaryotic cell

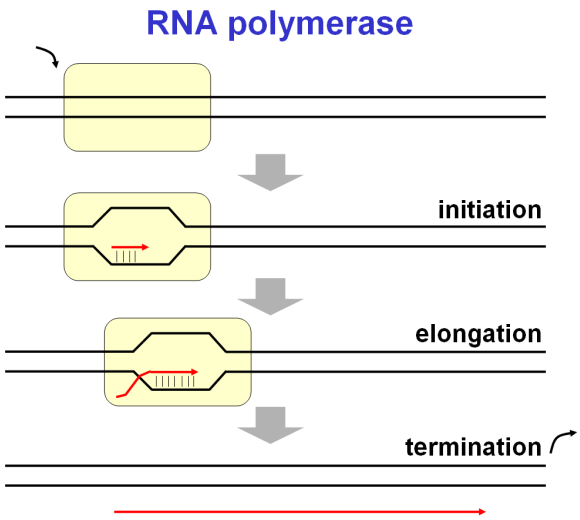


eukaryotic cell

Anatomy of a gene



A gene is a segment of DNA along the length of a chromosome. Transcription occurs when the enzyme RNA polymerase binds to the *promoter* region, initiates transcription 5'→3', and then ends at a *terminator*. Expression of genes can be regulated by proteins called *transcription factors*, which bind to the promoter and either block transcription or cause it to increase.



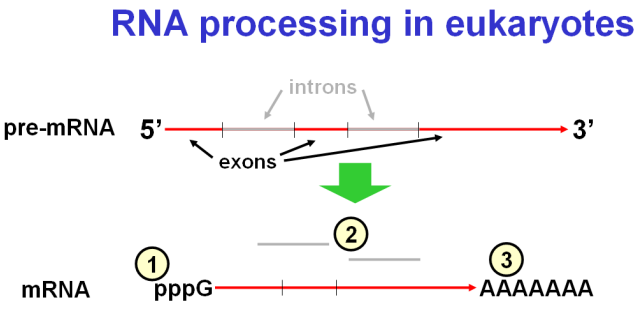
RNA polymerase will initiate transcription by unwinding the DNA. At initiation, incorporation of new NTPs will occur using the bottom strand as a template.

During elongation, synthesis occurs in the 5'→3' direction, similar to primase and DNA polymerase during DNA replication.

At termination, the RNA transcript is released, and RNA polymerase is no longer bound to the DNA.

(Exercise: Label all the 5' and 3' ends.)

The modifications that occur in eukaryotes to the 'pre-mRNA', to generate the mature mRNA, are shown on the right.

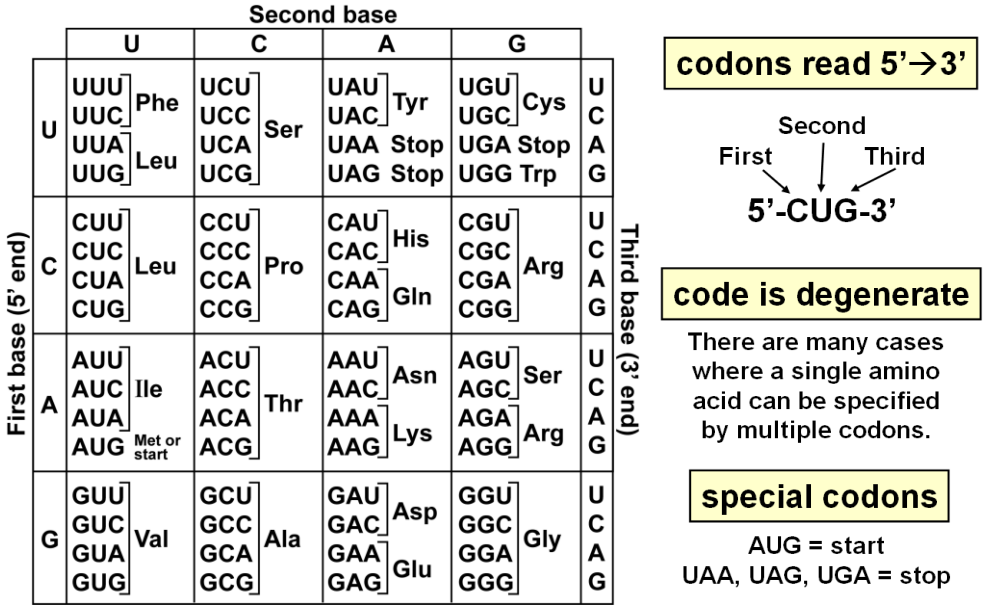


① **5' Cap is added**
* ② **introns are removed (splicing)**
③ **50-250 A's added to 3'end (polyA)**

The Genetic Code

Recall the Central Dogma: DNA → RNA → protein. Last time we looked at how mRNA, generated through transcription during expression of a gene, is a copy of the DNA sequence with U in place of T. How does the information in messenger RNA, which consists of only four possible bases, dictate the sequence of amino acids in a protein, which can consist of 20 amino acids?

The *genetic code* is the triplet code by which three bases (a codon) specify a single amino acid. Three bases together generate a total of 64 possible codons, whose corresponding acids are shown on a genetic code table.

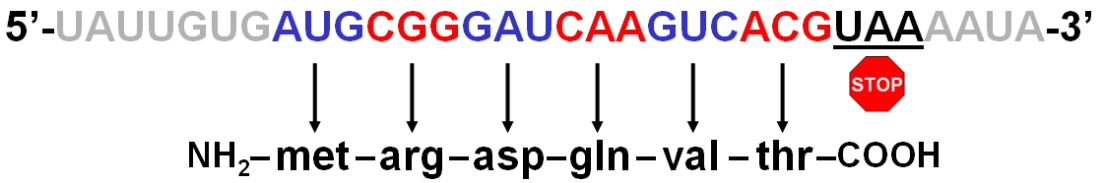


The Genetic Code is universal. The genetic code for most organisms is the same – that is, the same codons specify the same amino acids or stop codons. There are some rare exceptions. For example, mitochondria have a slightly different genetic code.

The Genetic Code is degenerate. With 20 amino acids and 64 codons, many amino acids are specified by more than one codon. This is called 'degeneracy' of the genetic code.

How to 'translate' an mRNA. Within each messenger RNA (either a mature mRNA in eukaryotes, or the primary transcript in prokaryotes) is an *open reading frame* – a *coding region* that begins with a *start codon* (AUG), proceeds three bases at a time to specify amino acids, and then ends with one of three *stop codons* (UAA, UAG or UGA). Stop codons are also called *nonsense codons*. Surrounding the coding region are portions of the mRNA that are not used for specifying the amino acid sequence, called *untranslated regions* (UTRs). There is usually a UTR at the 5' and 3' ends.

To translate an mRNA, start at the 5' end, and read until you see the start codon, AUG. This start codon will determine the *reading frame* for the remainder of translation. Take the bases three at a time, find the codon in the Genetic Code Table (which we will provide you on the final exam), and read the identity of the amino acid.



The start codon is always AUG for methionine, and it will be closest to the amino end of the polypeptide chain. The last amino acid to be incorporated will be closest to the carboxyl end.

In the next lecture, we will go over the enzymology of how translation works.

Study questions

These questions are to guide your studying. They do not cover all of the topics that may be on exams.

1. This is the biosynthetic pathway for arginine synthesis in *Neurospora*:

   A **B** **C**
   Precursors → Ornithine → Citrulline → Arginine

   Explain why a *Neurospora* mutant strain that is defective in production of enzyme B would be able to grow on MM + citrulline or MM + arginine, but *not* MM + ornithine.

2. Would the *Neurospora* strain described in the question above be able to grow on MM supplemented with all 20 amino acids? How about MM + glycine?

3. What was the purpose of the X-rays in the Beadle and Tatum experiments?

4. (Choose the correct answer.) A difference between prokaryotes and eukaryotes is:

   (a) mRNAs are spliced in prokaryotes.
   (b) genes in prokaryotes must all encode proteins.
   (c) In prokaryotes, RNA must be exported to the cytoplasm prior to translation.
   (d) transcription and translation are coupled in eukaryotes.
   (e) the transcript is usually not modified before translation in prokaryotes.

5. Place the following in order of occurrence: (a) release of primary RNA transcript, (b) unwinding of the DNA, (c) RNA polymerase binds to promoter, (d) export of mRNA to the cytoplasm for translation, (e) Addition of 5' cap and polyA tail, (f) elongation step of transcription.

6. The genetic code is 'degenerate.' What does this mean?

7. How many possible amino acids could a genetic code of four bases specify, assuming at least one start and one stop codon?

8. Translate the following mRNA into a polypeptide. (Hint: Remember to start with the start codon.)

   5'-AAAUGCCGGUAUGGAAGUUCCACGAAGGACCUAUCACGGCAUAAAUACUA-3'

Grades, Expectations and Studying in Biology 5A at UC Riverside

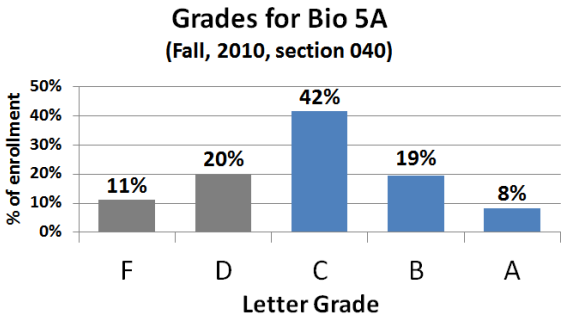
(Prof. M. Maduro, Jan 2015)

This document explains just about everything associated with Biology 5A that is not the material itself, such as how to do well and how the grades are determined. It is based on Dr. Maduro's experience having taught Bio 5A to over 3400 students since 2004. Some students may feel intimidated by the facts presented here, but the intent is to demystify how big introductory courses work at UCR, and provide advice on how students can succeed.

As the first University-level course in the Life Sciences, Bio 5A is a challenge for many students. If the cautionary notes in this document are taken to heart, some may be able to adjust their preparation methods at the start of the course instead of in the last couple of weeks, when it will be too late.

A summary of this document appears immediately below, but students are advised to read everything, as it may clear up some questions for other courses as well.

Summary. Exam scores are not curved or adjusted. Cutoffs for grades are determined at the end of the course. Typically, the average grade will be a C, the top ~5%-10% will earn an A- or above, and ~15%-30% of the class will earn a D/F. As an example, the letter grade distribution for 289 Bio 5A students in 2010F is shown at right, with the grade categories grouped together (e.g. B = the total of B+, B and B-). The distribution for another offering of the course might be very different. Making notes then re-reading them, or focusing on past exams, will result in only average grades. There are no shortcuts: To do well, students must attend all lectures, review frequently by practicing their ability to remember and apply facts and concepts, and not leave studying to the last minute. Exam questions will be new. Exams are multiple-choice, but many questions will require higher-level thinking. There is no extra credit. All grades assigned at the end of the year are final. In general, a student can repeat Bio 5A only once.



Below, various points are addressed individually, titled as questions or statements that Dr. Maduro has heard over the years.

1. First, a note about rumors, such as "My friend took this class from you last year and said you give bonus points… I heard that you will count only some of the quizzes… I heard that as long as you answer some of the clicker points, you automatically get a 5% bonus… I heard you never give As…The TA said you would give extra credit…" etc.

   Trust *only* what the course instructors tell you in class and what is written in the Syllabus for the course/section you are registered in that quarter. Do not rely on what your friends (and sometimes, even the TAs) may tell you about how grades are calculated in any course, or what you might read on a "rate-my-prof" kind of website – these sources of information may be wrong. Instructors often do things differently from each other and even from year to year. If you hear something that is not in the Syllabus or posted on iLearn by your instructor(s), it may not be accurate. Confirm it for yourself by talking to the instructor. No instructor can reasonably be expected to honor a statement made by someone other than themselves.

2. Second, students should keep everything in perspective. Many students will perform much worse in Bio 5A than they thought they would. Doing badly in any course does not mean you are a bad person or that you have no future. It only means that given the time constraints, motivation and the skill level at the time, a low grade was the result. This document may help students understand why they might not do well.

3. "Is this course the same as AP (Advanced Placement), IB (International Baccalaureate) or Honors Biology?"

   Bio 5A uses a similar textbook and covers similar material. However, the expectations for understanding may be different. The exams in Bio 5A will assess thinking and comprehension more than just straight memorization. In High School, tests may have been given at a different level. It really depends on the school and the teachers. Students who took AP Biology and did very well *may be* at a significant advantage in College-Level Biology but this is not guaranteed (see this study). Students are cautioned to *not* assume that having taken AP Bio means they will automatically do well in Bio 5A. It may have been a long while since the AP Bio courses were taken, plus many topics in Bio 5A might not have been covered at all by some AP Bio teachers, and for many students, their knowledge might include many misconceptions and knowledge gaps that were never corrected.

4. "Some of the things in the notes are different than what I learned in another course."

   Biology 5A will borrow from many subjects such as chemistry, but in a *biological* context. The textbook and this course will make simplifications to restrict the discussion to living systems. For example, ionic bonds can be extremely strong under the right conditions, but in cells, ionic interactions are generally much weaker than covalent bonds because of the water environment inside cells. Hence, in this course we will generalize and say 'covalent bonds are the strongest' even though it may not be true in all contexts. You will be responsible for learning and applying such concepts *as they have been taught in this course*. This is an important reason to attend lectures and carefully read all notes provided, even if you feel your knowledge base is very strong in a particular area. Students may dispute answers to questions on an exam based on these types of differences, but they should be cautioned that Professors usually default to "that is the way I taught it."

5. "Can I have special office hours with you for one hour a week, but separate from your regular office hours?"

   Maybe – it depends. For the typical Professor at UCR, teaching is only 1/3 of their job, and they are rewarded in their job primarily for their *research accomplishments* and *scholarly productivity*. Most Professors may not have time for anything other than the office hours they have posted. Professor availability is very different at a research University like UCR than it is at a state or community college. To be fair to all students, office hours cannot be viewed as 'study sessions' nor are they 'private tutoring'. Students should not go to their instructors' offices unannounced and expect to be 'served'. They should attend only during posted times and arrive with *specific questions*. They should not ask vague questions like 'could you go over photosynthesis again'. It is expected that students are regularly reviewing the material after each lecture and that they have already made an effort to understand a particular concept, but are struggling with some specific part that they will ask questions about. If students miss a lecture, they will not get a 'special lecture' in office hours. Some students come to office hours wanting to know how they should best prepare for the exams. This document contains all the information that is needed. If students want to know the level at which they will be assessed, sample exams have been provided. If students want more regular help, or are unable to meet with the Professor because of a time conflict, they should meet with the Discussion TA, laboratory TA, or Supplemental Instructors (SIs), who all offer their own office hours throughout the week. These graduate students (and senior undergraduate students, in the case of the SIs) are paid to offer office hours to students, and at the end of the quarter they are evaluated for their effectiveness, just like the course instructors are. Many students find that meeting with the TAs or SIs is extremely valuable. Students can also email the professors directly with specific questions, though they should really ask the TAs first.

6. "Aren't office hours meant only for weak students that need extra help?"

   Students should have an open mind about office hours. Dr. Maduro has found that the students that attend office hours regularly with specific questions are far more likely to be in the top 20% of the course at the end of the year. This is almost certainly because students who are reviewing the course material regularly will have specific questions sooner than those who will leave their studying until the last minute.

7. "What do I *really* need to know for the exams? Will you provide a study guide?"

   Everything covered in lectures, plus lecture notes that have been distributed on iLearn, plus any assigned reading, are all testable. Dr. Maduro has produced a detailed set of lecture notes that he distributes freely to the class via iLearn. At the beginning of the notes are "Learning Outcomes" or "Learning Goals." These are the very things that Dr. Maduro will use to construct questions for exams. The Learning Outcomes *are* the study guide, and they enable students to focus their study time appropriately. Students should actually make sure that they can do what the Outcomes say. The collection of past exams that Dr. Maduro also distributes is the next best resource students could have for seeing the level at which they are likely to be tested at, although it is not reliable to use past exams as the only study method.

8. "Thanks for the notes, but I hate having to print them. Can you hand them out? Can you post your Powerpoint slides?"

   The notes are offered as a tool for learning and students are not obliged to print or even read them. Money can be saved by printing two or four pages on single sheets, printing on both sides, or saving paper by using an iPad (or similar) to follow along and make digital annotations. Students can go to UCR's Printing and Reprographics or a store like Staples or Kinko's and have them printed at modest cost. Students could also use the notes from a student who already printed them in a previous offering, but the notes do have minor changes from year to year. The notes contain the Powerpoint slides embedded in them, so Dr. Maduro does not post the Powerpoint slides alone.

9. "If you make notes available, why should students come to class at all?"

   The notes will have *almost* everything you need to know, but they are not a substitute for attending class. Exams will be based on what gets covered in class, plus the notes and any other materials you are told to know. Dr. Maduro sees the notes as something between what a student might be able to write down in class and what a textbook contains. The classes also will have things like videos and clicker questions, though students will have access to these via iLearn.

10. "What should I do with the notes?"

    Anything you think will help you. Some students can do very well without reading them at all, but that does not mean you can do this too. The best strategy for using the notes is *not* just to highlight them. Students should take notes in class, and then combine these with Dr. Maduro's to generate a new set of notes. Dr. Maduro has observed that the students near the top of the class seem to be doing this all the time. Besides, using a highlighter is so passive that it probably produces *no learning at all*. See here and 'How can a student do well in 5A' below for more. (As a side comment, in most courses at UCR, students will not get notes like Dr. Maduro provides. Usually they will get only Powerpoint slides, and will have to rely more on textbooks and their own note-taking abilities.)

11. "Could you give us regular assignments for credit (i.e. some kind of homework)?"

    Creating and grading assignments for credit in a high-enrollment introductory course is time-consuming and difficult to manage. Many students tend to complain that *any* homework is just "busy work" with no purpose, especially if they feel they already know the material; and many students copy from each other, making it difficult to assign credit fairly. Prof. Maduro believes that students are in University to learn how to make the best use of all resources to build their knowledge base and critical thinking skills. The past exams, questions at the end of the lecture notes, and learning outcomes, can all be used as learning activities for individuals or small groups. This regular review of material (at least 2 hours for every hour of class) *is* the homework, and students are free to choose for themselves how they invest their time.

12. "Can I record your lectures?"

    Sure, if you think it will help. Dr. Maduro thinks the notes are sufficient, but some students feel that if they capture every word said in class they will do much better on the exams. Exams will test mostly concepts and their application, so focusing on learning these might be a better use of time than playing lecture recordings over again. Dr. Maduro will regularly tell students what he expects them to know for an exam, so if a student misses a class, a recording might help, although he believes there is no substitute for class attendance.

13. "Are we expected to know things covered in prerequisite courses?"

    Yes. Students are expected to have a working knowledge from the Prerequisite courses. For example, although the lecture notes and syllabus do not say it explicitly, students in Bio 5A are expected to know how base 10 logarithms and powers of 10 work, how to read a graph, how to calculate a molar mass, etc. because these are covered in prerequisite courses. If students find that their knowledge of prerequisites is poor, they must fill in this knowledge on their own. (Note that calculators will not be allowed on exams.)

14. "Will there be review sessions for the exams?"

    Dr. Maduro will not offer review sessions. In his experience, most students attend these to hear what *others* ask about or they expect to hear exactly what is on the exam. Many are not prepared with their own questions, or they ask for major topics such as cellular respiration to be covered again in a few minutes. Or maybe they are uncomfortable asking questions in front of other students. As review sessions do not cause a noticeable increase in overall class performance, they are not a productive use of time. Students will still have many opportunities to review: There are the Discussion sections, plus other instructors, the TAs or SIs may offer their own review sessions, and Dr. Maduro may offer extended office hours for the Final.

15. "I think you are wrong about having to study the notes and/or come to class. I can learn a lot from the old exams, and if I study them the night before the tests I will do just fine."

    It is possible, but highly unlikely. Unless they have previously mastered the material covered in Bio 5A, it is doubtful students will get much more than an average grade if they commit themselves to this strategy. It is easy to explain why many students find comfort in studying from past exams. First, it seems like a good shortcut: There is no need to read any notes or a textbook. Second, in previous classes, exams were simpler and repeated a lot of the same, low-level questions, but many instructors at UCR do *not* re-use exam

questions this way. That does not mean that the same topics will *not* reappear on a future exam, it means only that the exact same question will not reappear. Another important point is that the same concept can be tested in all sorts of different ways, so if a student memorizes how to answer a particular question one way, they may not know how to solve a similar question. As a general rule, the exams you will encounter at UCR, particularly in the sciences, are going to be more difficult than you might have seen previously. What got a student an 'A' in High School may be good enough for only a 'C' now.

Posting old exams has made at most a minor difference in student performance. Since Dr. Maduro began posting a collection of older exams on iLearn, the exam averages have been the same as before. This means that although there is now widespread access to past exams, the average student is not performing any better on the real exams. If it were the case that having access to many past exams was the big "secret" to doing well, then the exam averages should have moved way up. Part of the reason is that Dr. Maduro makes new questions for each exam. Another possible explanation is that as a result of the past exams being so readily available, some students are doing better but others are doing worse, so the averages stay the same.

Most students use the past exams in the least effective way possible. A lot of students will look at the old exams with the answer keys right next to them, answering a question and immediately checking the answer. If they got it wrong, they will generate some kind of shortcut to remember the correct answer (e.g. *if I see a pH question, the answer is* $[H^+] = 10^{-3}$). Sure enough, they will take the *same* past exam again a short while later and this time they get most of the questions right. But all they did is memorize the answers to *that* exam and generate a false sense that they have mastered the material. Students using this method of drilling on the past exams alone are genuinely surprised, and even angry, when they do not do as well as they had hoped on the real exam. They will blame the real exam for being more difficult than the sample exam, even though the exam averages are usually very similar.

The proper way to use past exams is as an assessment tool, and part of an overall strategy of preparation. At the very least, students should take an entire sample past exam under similar conditions as the real exam (i.e. giving themselves the same time, and without the answer key immediately available). They should then score it with the key, and then go back and learn the concepts that they did not master, and which led them to get the wrong answer. But even this is not enough. If students find that they are scoring about average on the sample exams, they will likely have a similar performance on the real exam, even if they go back and find out what they got wrong. If a higher score is desired, they *must* use a better strategy for preparing.

Aiming for average sets up a vicious cycle that can doom the entire undergraduate experience. It is unfortunate that students use a last-minute, study-from-old-exams strategy, as many will not find out until they get Midterm 1 back that they were underprepared. They may never really learn the topics in-depth, and will find the next courses in their life sciences program to be much more difficult. It should come as no surprise that this vicious cycle results in many senior students that end up discouraged and frustrated. The reverse is also true, however. Students that master such concepts as Mendelian inheritance and Gene Expression will find Biology 102 and 107A to be *much* easier as there will be a solid foundation upon which to build knowledge. An "aim-for-passing" strategy is self-defeating in the long run.

Leaving studying until the last minute will guarantee a poor exam performance. Many students like to study just before an exam because they rely on their short-term memory. This makes some sense for a straight memorization exam, and if there is a small amount of material to cover. However, many of the exam questions that students will see in University-level science classes cover a *lot* of material, and require thinking skills that cannot be acquired in one night. Students have trouble believing this, as their experience might have told them that Biology is just a subject that is about "memorizing facts." But concepts like Mendelian inheritance and its connection to mitosis, meiosis and fertilization, need to be thought about over many separate sessions. If students only read their notes (or worse, just look at the past exams) the night before an actual exam, they may be able to remember only a collection of easily-confused and unrelated facts – really, just groups of words strung together – with no real in-depth understanding. As only a few of the exam questions will work with this type of preparation, this strategy *guarantees* an average or below-average performance, unless the material was mastered previously in another course. Investing the same amount of studying over many sessions is known to be much more effective for learning (Distributed Practice).

See this page from Texas Tech University that explains how to study biology and succeed.

16. "Will the scores be curved?"

The main thing that matters is how a student's score compares with the average and with the top scores. Because the average will usually come out to about a C, scores can be thought of as being curved. However, scores will not be converted by a statistical method. If a student has 63 points out of 100 points for the whole course, it will not be adjusted. Curves are not applied because the distributions are usually not normal, and

because making big adjustments to raw scores is not fair to students at the top of the class. The precise raw scores that correspond to each letter grade will be determined at the end of the course.

17. "What determines the grade cutoffs?"

    Several factors affect final grade cutoffs. There is the distribution of the scores itself: The top scores get As, the middle scores get Cs, and the bottom scores get D/F, and the other grades are spread in between. Some effort is made to consider whether the exams may have been more difficult, or easier, than those of previous years. Grade assignments (e.g. % of the class receiving a B-/B/B+) from other offerings are often consulted to assure consistency across different sections. Finally, instructors may consider the engagement level of the class as a whole. If many students showed poor attendance or disruptive behavior in lecture and discussion, or little use was made of resources such as extra office hours and online materials, the instructors are less likely to be generous at the end of the year because they will see the entire class as underperforming.

18. "Why isn't there one grading standard applied to all offerings of Bio 5A?"

    Different instructors teach Bio 5A in different ways and with slightly different topics emphasized. They give different exams that change from year to year, and use different combinations of assessments and exam weightings to compute final grades. Different classes may have different cohorts of students in them. Hence, an absolute standard is neither practical nor fair. Hence, the same final point total in one section of Biology 5A might be a C+, while in a different section it could be a B-.

19. "How are letter grades assigned? Tell me the grade cutoffs."

    Grades are assigned in a thoughtful process in which the instructor(s), at the end of the year when all point totals are known, decide(s) the numerical cutoffs for particular letter grades (i.e. A+/A/A-/B+/B/B-/C+/C/C-/D/F). Grades are not automatically assigned by a computer. An important thing to note is that grade cutoffs from a different section of Bio 5A (even a past section offered by the same instructor) may be different. Some general information about grade cutoffs appears below.

    Instructors in Biology assign letter grades with the following in mind (see R1.1 here).

Letter Grade Expectations	
Letter Grade	Achievement level
A	Superior performance in all exams. Student can explain a particular topic (e.g. Photosynthesis) at many levels. Able to apply knowledge from multiple areas of the course to new situations. No major knowledge gaps from any part of the course.
B	Above-average performance in exams. Able to explain many concepts, but some details are lacking. Can apply some knowledge to new situations, but has difficulty excluding some wrong answers that represent misconceptions.
C	Average performance in exams. Able to recall many facts, but generally lacks a big-picture sense of how things fit together. Can apply some concepts to new situations. Has difficulty recognizing misconceptions in own knowledge. Knowledge gaps exist.
D	Below-average performance in exams. Knows some basic facts but struggles to apply concepts to new situations. Has knowledge gaps in many parts of the course. Some topics are known, but with misconceptions and inaccurate generalizations.
F	Inferior performance in exams. Student knows very few basic facts. Student is unable to demonstrate ability to apply concepts to new situations. Easily confuses wrong answers with correct ones as knowledge base is weak and superficial.

20. "What percentage do I need to get a 'B' (or some other grade)?"

    The average scores in Biology 5A are usually 50-55 points out of 100, which will likely (though not necessarily) correspond to a letter grade of C. To earn a B or higher, students must be well above the average scores (for example, higher than midway between the average and the top scores). For an A or A-, the raw score needed is generally at least 80 points out of 100, but this can vary from class to class. Do not take this as a guarantee of any grade, as it is only to give you a rough idea.

21. "I got average on the first midterm. Can I still get an 'A'?"

    Probably not. Students tend to show similar relative performance across all three exams. Some students

might be able to perform better in the second midterm and final by adjusting their preparation strategy. While an A may be out of reach, in such rare cases, it is possible to get a B+ or maybe even an A- with superior improvement over the next exams. However, when two midterms and a final are given in Bio 5A, the averages are usually higher on the first exam, lower on the second midterm and in-between on the final.

22. "If I am below average, will I still pass?"

    You might not. Because the average score typically results in a grade of C, scores that are well below average (e.g. at least 10%-15% below average) place students in danger of earning a D or F.

23. "I got __% in the first midterm, and __% in the second midterm. Can you tell me where I stand? What's my grade so far? What do I have to get on the final to get a B? If I get __% in the Final, will you promise me a B?"

    Grades are not a negotiation with the professor. The instructors assign grades to all students in the entire class after the Final Exam scores are known, and not sooner. It is unfair to ask them to predict or promise a course grade based on partial information. A good predictor of a student's final grade at the end of the year is the average of the two midterm scores. Using the grades from fall of 2013 allows us to see what kinds of grades students got at the end of the course, compared with the average of their two midterm scores:

MT1,MT2	Final Course Letter Grade (Fall, 2013)										
Average	F	D	C-	C	C+	B-	B	B+	A-	A	A+
>90										■	■
85-90										■	
80-85									■	■	
75-80								■	■	■	
70-75						■	■	■	■		
65-70					■	■	■	■	■		
60-65					■	■	■				
55-60			■	■	■	■	■				
50-55		■	■	■	■	■					
45-50		■	■	■	■						
40-45	■	■	■	■	■						
35-40	■	■	■	■							
30-35	■	■									
<30	■										

On the left is a table that shows the final grades received by students compared with the average percent on the two midterms (each weighted 25% of the final grade). To use this chart you must first compute the average of your two midterm scores. For example, students whose average of the two midterms was 62.2% would look up the 60-65% row, and see that these students received grades between a C+ and B, the most common grade (darker shading) being a B-. If the average of the two midterms was 44.1%, you would predict a final grade between a D and a C+, the most likely grade being a C- or C.

The reason the grades do not always correspond to an exact grade is due to two factors: (1) The averages shown are a range; and (2) Many students did slightly better on the final exam (and quizzes) or slightly worse. Unless a student's scores are at the very top or bottom of the class, it is difficult to predict a final grade because it can change a lot depending on the final exam score.

Another way that students can predict their letter grade is to compare their scores to the rest of the class. An average is around a C. Students at the top correspond to an A, while those in between are around a B. Just below average is a C-, while farther below average corresponds to a D or F. So if a student scored average in both exams, they are likely to receive a 'C' in the course if they maintain the same level of performance. If they did slightly below average on one exam and average on another, then they may be around a C-. Note that these are only rough guidelines; the average grade in any particular offering can change at the discretion of the instructor. (Note also that the offering of Bio 5A that you take may have only one midterm and not two, and that some instructors assign significant points to other assessments.)

24. "Can you tell me my grade early?" (just after the Final exam, but before grades have been posted)

    No, because it will not be known until the grades are calculated for the entire class. Therefore, every student will learn their grade at the same time.

25. "How many people do not pass Bio 5A?"

    The rate of D/F in Biology 5A is between 15-30%, though it can sometimes be outside that range. This can be confirmed on the website www.myedu.com, which has historical letter grade distributions for particular instructors. (Note that this website groups letter grades together, so A+/A/A- are called A, and B+/B/B- are called B, and so on.)

26. "Why is the failure rate high? Is the main purpose of the course to weed people out?""

    Bio 5A is no more a 'weeder course' than introductory Mathematics and Chemistry, which many do not pass as well. The purpose of Biology 5A/5B/5C is to give Life Science majors the fundamental skills they need to enter a rigorous program of courses in the Life Sciences. As Bio 5A is the first university course in the life sciences for most students at UCR, many will find themselves challenged. At institutions with similar

demographics as UCR, failure rates of introductory Biology classes are comparable. Students that get As in introductory Biology tend to get As in Math and Chemistry, suggesting that strategies that succeed in introductory Biology are the same as those that produce success in other science courses.

There are many reasons students do not do well in courses like Biology 5A. Some students may have expectations about the difficulty level of multiple-choice tests based on their past experience. Students tend to overestimate their academic skills because they had good grades in high school. They may expect that multiple-choice questions will be superficial, so they study for recognition and word association, and not deep understanding. Some students may just not know how to read in order to understand. Students often expect (or hope) that questions from past exams will be repeated, so they spend most of their time using past exams as their main preparation method. Some students may not use their study time effectively. For others, it may be that they have chosen to major in Biology for the wrong reasons, and are playing neither to their academic strengths nor their motivation and interest. Others set their goals low, are not able to manage their time effectively, or misjudge whether their performance on exams will constitute a passing grade at the end of the year. Still others may have time commitments or other obligations that prevent them from devoting the effort needed to do well. While students may feel that everyone in the class starts with the same 'blank slate', it should be obvious why this is false: When all the above factors are combined, in any large class there will *always* be a wide distribution of scores from very low (~ 20%) to very high (~90%).

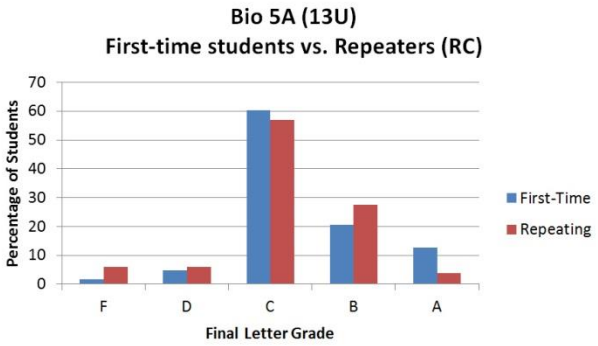
27. "Why not pass more students? Are you required to fail a certain amount of students?"

    Instructors at UCR do not have a grade quota. Students who receive the lowest passing grades in Bio 5A are likely to earn a D/F in the next courses (i.e. Bio 5B, 5C). Passing more students in the lower-division courses is not the solution, because these students will not be successful in the later years of their program.

28. "How many times can a student repeat Bio 5A?"

    If a student did not pass Bio 5A on their first attempt, they are permitted only <u>one more attempt</u> to take the course. If a student passed the lab (BIOL 05LA or BIOL 020) the first time, they need only repeat the lecture.

29. "I am repeating the course. How well do repeaters do in Bio 5A?"

    Many students will take Bio 5A a second time because they did not earn a C- or better the first time. *All students are assessed the same way regardless of whether they have taken the course before*. To see if having taken the course before is of any advantage, we can compare the final letter grades of students in the 'RC' (Repeat for Credit) category with students taking the course for the first time. A sample result is shown here for summer of 2013 (115 students, about half were RC), but the result has been similar in other offerings. The trend is clear: Repeaters are far less likely to get an A than first-time students, but are a bit more likely to earn a 'B' or 'F', suggesting that students who are repeating the course do not have any advantage over those who are taking it for the first time. If anything, they are at a slight disadvantage because they are less likely to earn an A. This seems to be counterintuitive, as we might expect that if a student has already seen the material, they should be more familiar with it. In reality, many students taking a course for the second time find it difficult to maintain their engagement, and may be expecting to get a different result with the same study methods. They may be tempted to skip lectures, and possibly miss material they did not see the first time. They may become overconfident in their abilities, depressed that they have to repeat the class, or simply do not want to do well (only pass). Perhaps, as most repeating students passed the Bio 05LA laboratory requirement, they lose the additional reinforcement that might come from the lab course and lab TA (though they still have the Discussions). Another way to interpret this is that the students most capable of an 'A' when repeating Bio 5A already passed the course the first time they took it, so they are not in the 'RC' category.

    Some students will take Bio 5A again even though they received a passing grade ('XC' – duplicate credit), but Dr. Maduro has had too few students in this category to make a reliable conclusion about their performance.

30. "How can a student do well in Bio 5A?"

    There is no single answer to this question that works for everyone. Predicting success in Biology 5A is similar to predicting success in any course. It depends on what you already know, how motivated you are, how much

time you are willing or able to dedicate to learning the material, how you learn, what study skills you already have, what your goal in the course is, and even what your overall career goals are. Students enter University with different backgrounds, capabilities and expectations, and people learn at different rates, so there is no one-size-fits-all method.

As a general rule, students should regularly review material after class, two hours for every hour of lecture. They should attend all classes, sitting in the front if possible, and avoid distractions like social media. They should make new notes and consolidate their information, and regularly reinforce it. Students should use all available resources, and not just the past exams. For Bio 5A, this includes the Discussion section, office hours, any questions or exercises supplied by the instructors, extra materials supplied by the textbook publisher, the supplemental instructors (SIs), the Learning Center, and the Internet. It is probably impossible to use all of these resources, so students should choose which work best for them. If there is one piece of advice, it is that students should know the material well enough that they can teach it to someone else in their own words. This could be done by giving themselves a mini-lecture on a particular topic, or re-creating summary notes from memory. The most important strategy is to make learning "active" in which students have many opportunities to self-test and face the possibility of getting things wrong; only then can the most efficient learning take place. Equally important is to spread study over many sessions and not try to cram material at the last minute. There are many education studies that prove that these methods of *practice testing* and *distributed practice* are the most effective learning techniques a student can use (see here, here and here).

With respect to active learning, a good analogy is to think of what a pianist would do if they had to play a new piece in a concert in ten weeks. Which strategy would work better: Reading the music and putting a highlighter through it right up until the concert? Or, actually going to a piano to play it right away? Of course the best performance will result from actually playing the piece starting as soon as possible. When applied to a course like Bio 5A, this means preparing for exams by practicing *remembering the material* from the very first lecture. If students wait until the exam to find out they do not know the material well, it is too late.

An important reason why students must "step up" their preparation methods is that Professors generally test for *application* of concepts rather than straight memorization. There are many sources of information on how to study for such college exams, such as here and here.

31. "I was an 'A' student in High School, and now you have made me a 'C' student. It is your responsibility to teach me, therefore you are a bad professor, and you are to blame for my poor performance."

    In fall of 2009, three different lecture sections of Biology 5A, taught at different times in the same quarter, did an experiment. On the final exam, the instructors included an additional 20 questions that were identical across all three sections and which tested across the entire course. Scoring *only those questions*, it was found that the average in each group of students (between 100-300 in each class) was within 1% of 52%. That result strongly suggests that it does not matter who is at the front of the room. As four of the professors teaching Bio 5A at that time were (or became) recipients of UCR's Distinguished Teaching Award, this leads to the conclusion that the course is difficult because of the material itself, and *not* because of the difficulty of the exams or the differences among professors. It also reveals that the biggest factor in doing well is how much students are willing to invest in learning the material, and how well they invest this time.

    A corollary from this experiment is that a student who drops Bio 5A only to repeat it from another instructor will not find the course to be any easier. Indeed, Bio 5A may be *more* challenging for repeaters (see the question above about how repeaters do in Bio 5A).

32. "The exam questions are really tricky (and therefore unfair)."

    This is the first thing students say when they do poorly, but it is just not true. Yes, the tests are more *difficult* than in High School, but that is not because they are deliberately trying to confuse students through trickery. It is because many of the questions are at a higher level of Bloom's taxonomy: They require reasoning skills that many students have not developed. In High School, most questions were at a lower Bloom's level. Why do tests at a University do this? It is because being able to memorize a collection of facts, without understanding their meaning and interconnectivity, is a useless skill for the working world today. Anyone with Internet access can easily retrieve facts without any knowledge of concepts. Preparing students for the demands of modern careers, with skills to solve problems, is a central goal of a University education. Of course there are many things that have to be memorized in a course like Bio 5A, but memorization without comprehension is not going to result in the highest grades when you will be asked to *think* on exams.

    "I've taken multiple-choice exams before, and yours are way trickier." That is because the exams you took before did not really ask you to think or discriminate – you could rely on 'familiarity' to guess correct answers. In Bio 5A as in other science courses, the exams are used to assess how well students comprehend

the knowledge conveyed in the course and to measure how well they have acquired reasoning skills. The most effective multiple-choice exam questions are designed so that a student who understands a particular concept will be able to choose the correct answer, while students who do not understand are pulled away from the correct answer and will choose a non-correct answer. Many students expect to be able to eliminate answers before even reading the question closely, using rules such as "pick the longest answer," "pick the most detailed," "eliminate the vague answers," "the answer is usually B or C," or "if two answers look like opposites, one of them is correct." Students are cautioned against using this type of approach, as different instructors design their questions differently. Good multiple-choice questions *always* appear as if they are trying to deceive, because there is one right answer surrounded by several wrong answers that seem right. This is because instructors frequently use common misconceptions as non-correct answers on exams – they do not just make alternate answers by making the right answer incorrect. Falling for common misconceptions also gives students the impression that they have done better on an exam than they really have. When it comes to making multiple-choice tests that effectively evaluate knowledge, it is standard practice to use misconceptions as non-correct answers. See this web page under 'Distractors'.

Some students say after an exam that they made "silly mistakes." This usually means that they had knowledge gaps and were easily confused by the alternate wrong answers, though many students do not want to admit this to themselves. Students are advised to read exam questions and answer choices very carefully. They can practice with the hundreds of questions in the past exams that were made available at the start of the course. They can attend class regularly and practice their reasoning using the clicker questions. (Remember also that during the actual exam, students can ask for clarification of a question.)

Dr. Maduro has been making multiple-choice exams at UCR since 2004. Statistical analysis has shown that his questions have an average point-biserial correlation of ~0.40 and that the exams have KR-20 reliability coefficients of ~0.80. (Desirable point-biserials are $\geq$20, and KR-20 are $\geq$60.) This means that the exams discriminate well among students and are reliable measurements of achievement.

33. "The practice exams were much easier than the real exams."

    This statement is sometimes *mathematically* correct, as the averages do change from year to year. However, the differences are not huge, and sometimes the real exams are slightly easier. A student that feels this way probably spent a lot of time drilling on the past exams with the answer key right in front of them, or worse yet, they first printed off the exam and then circled the correct answer on all the questions without even trying the test first. Over time, by reading the same exam questions and answers over and over again, students build up a false sense of their skill level with the material. They eventually have memorized the past exam answers so well that they can answer them with high accuracy – and therefore expect that they will get 80% or higher on the real exam. Obviously, this is a big mistake!

    Surely students can appreciate that because the exams they will see have *different questions*, they are likely to perform the same on the real test as they did on the practice exams *the very first time they tried them*. Indeed, if they marked all the correct answers on the practice exam before trying the questions, they have denied themselves the opportunity to truly assess their knowledge and identify weaknesses.

    Our best students know that trying to "game" the process does not work in all situations for all exam questions like it might have in High School. In University, you might be able to bring up your knowledge and exam scores a little bit by drilling on past exams, but in the end, you will *never* be at the top of the class with this strategy alone. In Dr. Maduro's experience, the top students understand the material so well that they could get up in front of a class and teach it. (Some do, by becoming SIs the following year.)

34. "A different section of Bio 5A had easier exams / shorter exams / more time for their exams / etc. This is not fair and I am being punished for being in your class because it is harder."

    Students will be assigned a grade based on their relative performance in the section they are actually in. Comments like the above sound like a student looking for something to blame other than themselves for their poor performance. Grade distributions are compared between sections and across time to assure a general consistency in the amount of As, Bs, etc. As evidence that this is the case, students can compare past sections on pick-a-prof.com -- the grade curves are fairly consistent between sections and across time. In addition, with any course offered by different people at different times with different TAs and resources, it is always the case that a particular group of students overall may perform slightly better or slightly worse in a different section. There is no practical way to control for this.

    The main point is that when it comes to the assignment of grades, students will be evaluated according to instructor expectations and to the other students in their *own* section.

35. "This is an introductory course. Students should be tested just on straight memorization, plain and simple."

    Being able to associate words together is something that might have been emphasized in high school, but that is not how solving problems works in the real world. Straight memorization does not directly translate into the ability to apply knowledge to new situations. Besides, Biology 5A asks students to understand and apply only the *most basic facts* about cell and molecular biology – not the in-depth knowledge that will come with Biochemistry and other life science courses in the upper division. Believe it or not, if you stay in the life sciences, in retrospect you will see that Bio 5A is actually not that challenging in terms of the material itself.

    "But I don't need to be able to think to get into medical school." Actually you do, for the Medical College Admissions Test (MCAT). According to Kirch *et al.* 2013 (*JAMA* 310: 2243-4), from spring of 2015 the MCAT tests "critical reasoning skills and the ability to apply knowledge to practice in diverse settings." It "emphasizes outcomes by testing how well applicants can apply what they have learned." Therefore, exams that test application of knowledge provide *exactly* the kind of training that is needed for a necessary step for getting into Medical School, not to mention actually being a practicing physician.

36. "Your exam questions keep changing and ask about concepts in a way that is different than how it was presented in the class or in the notes. How am I supposed to study if the exams ask things differently of me than what I memorized?"

    As noted many times in this document, learning is only partly about memorization: More importantly, it is about *understanding* and *applying*. Straight memorization of diagrams or tables is not real knowledge, and students who think that way will be very frustrated with University. Of course, test questions will ask on the same topics as what was covered in class and presented in the notes, but only with new situations can instructors really be assured that students are understanding the concepts rather than just memorizing a diagram or a past exam question.

    Students have to break out of the habit of thinking that straight repetition and memorizing will get them good grades in University. They must take their learning to a new level and aim for understanding and applying.

37. "Exam averages of 50% mean that your exams are unreasonably difficult."

    Exam averages around 50% are *just where the instructors want them*. This allows a good separation of students at the top and bottom of the class. If the average was 80%, it would be difficult to separate grades like B+ and A-. If the average was 35%, it would be difficult to decide C- *vs*. D. Averages around 50% are typical for introductory science classes at campuses with a student body similar to UCR.

    Besides, if the exams were unreasonably difficult, no one would ever get over 80% on them, which is just not true. Many students in the top 10% of the class will get more than 80% of the questions correct on all the exams, and every few years there are students that get 100% of the questions correct on at least one exam.

38. "I read and re-read the notes and textbook every night for three hours, and still am getting only average scores on the exams. But I was an 'A' student in High School. What am I doing wrong?"

    You might not be doing any one thing wrong. It is probably a combination of many factors.

    First, students need to get used to the idea that exams at the University level are much more difficult than in High School. In High School, exams were given at a lower level, and more frequently (typically at the end of each 'unit'), so that each exam covered less material. In Bio 5A, there is *a lot more* to know for each exam. The study methods that worked for easier exams on narrower topics will just not work now at the University level as the expectations are *much higher* and the knowledge base *much more complex*. There are larger issues at work. For starters, only the top 12.5% of high school students are in the UC system, so most of your 'competition' is not even here. Resources for many public schools depend on student performance in classes and on standardized tests, so it may be in the best interests of the school that tests are made as easy as possible, and that they train students to perform well on standardized tests. At a University such as UCR, students are *not* assessed by standardized tests, and resources are allocated differently. It is in the University's best interests that only the top students receive As, as otherwise a degree from that institution will be judged to be inferior. Professors do not teach as many classes, and may have more time to make new exams. They are free to make any kinds of tests and questions they wish, focusing on measuring *learning outcomes* rather than trying to train students to perform on a standardized test. In High School, many teachers use test bank questions almost exclusively; these questions are generally of a lower level and do not assess real understanding. Taken together, all these reasons explain why tests are generally easier in high school.

Second, Bio 5A covers a lot of material – something like 300+ textbook pages. Students should pace themselves by reading textbook chapters or lecture notes in advance of class, attending every lecture and paying close attention. A common mistake is to underestimate the amount of material and the amount of time it takes to truly learn it. As mentioned above, in high school there were many more exams, and each one covered less material. But in Bio 5A, there are fewer exams, so each covers *a lot* of material. For Midterm 1, there are over *100 pages* of textbook reading, and around 30 pages in Dr. Maduro's notes. If a student decides to read the notes, if they had three hours to study, they would have to read them at a rate of one page every six minutes, while learning dozens of new terms and concepts. If we add trying to do the sample exams, there are five sample first midterms, and even if only half the questions were attempted, that is still around 80 questions, and they typically take about a minute or two each. There is just no time to effectively learn so much material and try so many past exam questions. Many students, who have left studying until the last minute, see how much material there is and panic – so they decide to forget about the textbook and notes, and just try to drill on the exam questions. But as noted above, since exam questions will be different from the past exams, this last-minute approach is no substitute for taking time to learn the material at the right pace. The result is that the students have essentially no more knowledge for an exam than they had before the course started, and even if they have learned something, they will be a bit uncertain about it – so they will be highly likely to choose wrong answers.

Third, students must use their study time effectively. A lot of students see 'multiple-choice test' and decide 'aha, just memorization, so study the night before'. This is a *big* mistake. Yet some students will spend the recommended two hours of study for every hour of class, but they will do so the way they did it in high school: Passively reading notes, attending about 2/3 of the lectures, and trying to memorize answers to questions from past exams. Even this approach will generally produce an average grade because it does not work well for higher-level learning. To do better, students need to be able to connect concepts and apply them to new situations. They must use active learning strategies where they are constantly testing and re-testing their knowledge. They must not have big gaps in their understanding. They must focus their study on the topics they understand the least, and not merely refresh themselves on what they already know. A good start is to attempt to re-create notes from memory, while explaining the concepts out loud to themselves or to a colleague. They should choose a location that is free from distraction, turn off their cell phone/tablet/computer, and dedicate focused, uninterrupted time to study. They should spread their studying out over many sessions, and not try to learn everything in one sitting. Students should rehearse their *recall* – their ability to remember facts and apply them – which is the skill that is needed during an exam. Simply re-reading notes without practicing recall, even if it is done for many hours, is not effective at the college level.

Finally, students should set their goals high, and aim for *mastery* of the subject, not just passing. If a student's motivation is not strong, then their grade will reflect this. *You will get out what you put in.*

39. "What are the top students doing differently than me?"

There is little doubt that the vast majority of students believe themselves to be of above-average intelligence. But straight intelligence alone is just not enough to achieve at a University. It must be matched with skills that can translate that intelligence into achievement. It seems that many of the best students at UCR come to the campus *already prepared* with a knowledge base and a set of skills needed to do very well. For example, many have taken AP, IB, or Honors Biology in High School, so they start Bio 5A at an advantage. But that does not explain it all. Straight-A students know how to balance their time and they do not let distractions interrupt their career goals. They are committed to doing well in their courses, because they know that GPA is one of the most important determinants of their future success. They do not settle for having incomplete knowledge: They make the most effective use of resources to achieve *full mastery* of a course. They spread their studying out over many shorter sessions, and use their study time with the highest efficiency. This explains how many straight-A students can attend all lectures, hold part-time jobs, carry a higher-than-average course load, manage several volunteer activities, and still get very high grades: They have been doing this since middle school. They have optimized a pattern of study and reinforcement and made it part of the way they function.

One might think that the best students are that way because of some gift that they magically have from birth, enabling them to skip half the classes, casually study for an hour for a final, and ace it. There might be people like this, but in truth they are very rare. Most 'A' students simply *behave* like 'A' students. It may be surprising to learn that most of the top students have nearly 100% attendance in lecture. They usually sit at the very front of the class so they are not distracted by those around them and so they can see/hear the Professor better. This is probably not so much to learn the material better, as the well-prepared student has already read the notes and probably the textbook; the top students attend class to learn *which things to focus on for the exams.* Students that skip class have no choice but to try to learn everything in the notes,

because they do not know which things were emphasized in class. Then they really are studying things that won't matter for the exam, and hence not studying efficiently. An audio recording of the class might help, but then they are 'going to class' anyways when they listen to the recording, so they might as well be in the lecture room. Getting someone else's notes, or the Professor's notes with a highlighter in them, is probably not an effective substitute.

Another thing the top students do involves thinking about exams from the point of view of the Professor. They ask themselves, what are the concepts that the Professor really emphasized in class? They think about how the Professor is likely to test that such concepts have been understood. This strategy is a closely-guarded secret of A students, but now you know it.

40. "How do the in-class 'clicker' questions compare with real exam questions?"

In-class clicker questions are generally simpler because fewer words are used, though compared with a midterm question, a similar amount of time may be used to read and answer them (e.g. ~90 seconds). The averages on the clicker questions are similar to the averages on the exams (~50-60%), suggesting that the difficulty level is similar, but this is misleading. Most students in class have not studied the material between lectures and are trying to guess the answers based on the knowledge they had before the course started, while the exams reflect student performance after they have dedicated some time to studying the material, so they would (in theory) be better prepared for exam questions. Hence the clicker questions are a sampling of student knowledge *before* studying, while the exam questions sample knowledge *after* studying. The exam questions are definitely more difficult overall than clicker questions, but the averages come out similar. There is another factor at work: All students must take the exams, but only those students in class with a clicker will actually contribute to the clicker responses. Hence the clicker questions may be a non-random sample of students that are generally more motivated, as they have chosen to attend class and participate.

Since Dr. Maduro stopped giving points for clicker questions, he has been able to repeat the same questions in different years, and found that the proportion of students getting the clicker questions correct does not deviate very much from year to year. For example, if a question was answered correctly by 50% of the class in one year, the same question scores about the same the following year. This means that classes are very consistent from year to year. But – see the next point.

41. "If the class does badly on clicker questions, will the exams be made easier?" (or, "If the class does really well on the clicker questions, will you make our exams harder?")

The performance of the class on clicker questions, good or bad, will have *absolutely no effect* on the difficulty of the exams, nor will the professor be more or less tempted to put particular clicker questions on the exams. Students should forget about trying to rig the clicker question results as if it would cause the exam difficulty or assignment of grades to change. Rather, if students do very badly on the clicker questions, the professor is likely to think the class is an underperforming group and award lower grades overall at the end of the year. Besides, during clicker questions students can talk with each other, they can search the Internet, and the clicker questions are shorter (and hence less complex) than actual exam questions. Hence, there are reasons to expect that students will do *better* on the clicker questions than on exams.

As Dr. Maduro no longer gives any points for clicker participation, students should use the clicker questions as an opportunity to regularly assess their learning. In the past when Dr. Maduro kept records of clicker scores over several years, the trend was very clear: <u>Students who do well on clicker questions usually do well on the exams</u>. The reasons should be obvious: Such students either have more knowledge going into the course, and/or are keeping up with the material as the course progresses – both of which are obviously correlated with doing well on the exams. Conversely, this means that if you find yourself doing poorly on the clicker questions, you may be at risk of doing poorly on the exams.

42. "I heard that clickers count for bonus points in another section/offering of Bio 5A or in another course. Why don't you give any points for clickers? Can you post my scores so I can see how I am doing? And sometimes, you don't use the clickers at all, why is that?"

Use of clickers is *entirely* at the discretion of the instructors. An instructor can choose to not use clickers in an entire course, or sometimes an instructor intended to use them in one class but ran out of time. There is a body of education research that shows that using clicker questions in class is better than not using them, even when no points are given. Dr. Maduro has stopped giving any course credit for clicker use for several reasons. (a) It is impractical to prevent cheating in which students bring in their friends' clickers. It is unfair for students to earn bonus points when they are not even in the room, and it is also a violation of Academic Integrity policies. (b) The purpose of the clickers is to get students to talk about the concepts and practice thinking through the types of questions they will get during exams, as well as to reveal misconceptions that

can be corrected by the instructor. The value of this exercise is still there, even if students receive no points for participating. The instructors generally post the clicker questions (after the class) on iLearn, so students can see the questions that were asked and should not waste time trying to copy them down or take pictures with their phones. Note also that Dr. Maduro will not re-use clicker questions on the exams. (c) With so many students, there are always issues with those who forgot their clicker at home, the battery died, or the clicker is broken. Many students forget to register their clickers, or they replace them mid-quarter, and so on. It also takes a lot of time for the instructors to regularly post clicker scores. If students want to know how they are doing, they can keep their own records of their scores. (d) Forcing students to come to class (i.e. with the clicker points) goes against the idea that we wish to allow students to make their own decisions about their learning. Good students generally already do many things associated with good performance on the exams, including attending class regularly. Thus, they do not need an additional incentive to attend lecture.

43. "Can you please post our clicker scores? I want to track how I am doing."

    Sorry, Dr. Maduro will not do this for you. Besides, you can easily track your own performance by attending class and noting whether you got questions right or wrong as they are given.

44. "Are you using the clickers as a sneaky way to take attendance?"

    Nope. Students can see on the Course Syllabus that "attendance" does not appear as a grading criterion. That is because no student is required to attend the lectures at all – they only have to show up to the exams. Therefore, skipping class will not cost you points, and attending class will not give you some kind of bonus points. Besides, as clicker use is voluntary, and people can use clickers that are registered to someone else, clickers are not a completely reliable way to take attendance. (Note that attendance of Discussion sections may be mandatory, and attendance may be taken there.)

45. "Will the Discussions be a summary of the lecture material?"

    The Discussions are used to enhance understanding of the lecture material, but there is no way they can substitute for lectures. Think about it: Bio 5A covers some 300+ textbook pages. There are only 10 Discussions the whole quarter. And some of the Discussions will have quizzes, fall on holidays (and hence be canceled), and one or two will spend some time going over the midterms. Plus a lot of students simply skip Discussions altogether. That means students may spend less than five hours in the Discussions over the entire 10-week quarter – a time period that makes it *completely impossible* to summarize 300+ pages of textbook material and some 25+ lectures. There is just not enough time in the Discussions for them to serve as some kind of substitute for lecture time.

46. "Can I have an extra credit assignment to bring my score up?"

    Dr. Maduro does not offer extra credit. (Most Professors will not do so in any Science course.)

47. "Can you bump up my score at the end of the year if it is close to a cutoff?"

    All grades are assigned by the course instructor(s) and will be final unless there is a disciplinary issue or a grade delay (see here under R1.8.1 and R1.7). Grades are given on the basis of *achievement*. In Bio 5A, that means performance on exams and quizzes. Some students believe that they can ask for a higher letter grade after a course is over, using arguments such as high difficulty of the exams or quizzes, claims of having taken the course under some kind of special circumstances, the need for a higher grade to apply for a professional school or to meet a degree requirement, or that the grading was somehow unfair. A student can legitimately complain about an assigned grade, but they must be able to prove that the grade was given for non-academic reasons (see here under R5).

    "But I tried really hard": Sometimes, even though a student may have made the effort, they do not earn a good grade because they were unable to perform well on tests. This is unfortunate, but is a reality of life. The only thing within a student's control is to correct the shortcomings in their preparation methods early on.

    "But I did better on the first midterm and final. Can you base my grade on those exams instead?": The exams all count for what the Syllabus says they will. It is not a "best two out of three." That would not be fair to the rest of the class. Yes, some students may do badly on one exam for a variety of reasons. But in the end, the fairest grading system recognizes that a student who did well on all three exams deserves a higher grade than someone who did well on only two of the three. The instructor(s) may give some consideration for these things at the time of deciding the grade cutoffs, but no changes will be made after the grades are posted.

48. "I'm not good at concept-based learning. Therefore, your testing methods are biased against me."

    In Biology and most subjects at a University, students need to learn how to become comfortable with learning and applying concepts. Memorizing disconnected facts and statements will just not be good enough to do well on the exams. Students need to take a look at their learning strategies and adjust them.

49. "Bio 5A expects students to learn too much material for an introductory course."

    Bio 5A is a *University-level* course intended for students who have chosen to major in the Life Sciences. In general, science courses for majors are challenging. At a University, students are expected to learn at a faster pace than high school and to think at a higher level. Exams from other introductory biology courses found by Internet search suggests that Bio 5A at UCR has a similar level of difficulty compared with similar institutions. Shifting the blame to the Professors or the University is very easy to do, as it takes all responsibility off of the student and removes the motivation to work for self-improvement. Good grades have to be earned; they are not an entitlement. We give students all the materials we can for them to be successful, but they have to do the work.

50. "How are the exams made? How many questions will there be? How many versions will there be?"

    Dr. Maduro makes new questions for each exam by using the Learning Goals that appear in the notes as a starting point. He does not use test bank questions or questions from old exams. Some will be of the simple memorization/recall type, but many will require students to apply scientific reasoning to particular situations. The biggest problem students have is selecting out the *wrong* answers. This is because these use misconceptions, scientific terms and plausible (but incorrect) alternatives designed to pull students away from the correct answer if they truly do not understand the concept being tested in the question. This is why merely being 'familiar' with a topic, such as knowing that certain words tend to appear together, will not be enough to select out right from wrong answers.

    Exams are assembled in multiple versions with the question and answer orders changed. The letter choices are randomized to eliminate bias for any particular letter. For Dr. Maduro's exams in 2013-2014, each letter answer was correct 20% $\pm$ 1.4% of the time, indistinguishable from random chance (n=750 questions, $p>0.7$, χ^2 goodness-of-fit test).

    Note that the TAs will see exams for the first time when the students actually take the test. Hence, they have no knowledge of what questions will appear.

    The total number of questions depends on the exam. When he teaches the entire course, Dr. Maduro typically has 35 questions on the midterm(s) and 50 questions on the final, but this could change from year to year. More recently he has been prohibiting 'bathroom breaks' to control for cheating, so the tests tend to be shorter than they have been in previous years.

51. "Can you give me more practice exams?"

    The many exams that Dr. Maduro provides on iLearn are plenty and no more will be made available. If a student wants to only practice dozens of exams as a substitute for learning, this strategy will not work well in the long run. Students are encouraged to use the practice exams as a *part* of their preparation and not as the sole studying tool.

    There are many more past exams that exist besides the ones provided, so resourceful students can obviously collect these if they wish, but they should not expect that the instructors will provide any keys to these exams. Students can also go online and search for exams from other instructors at UCR or other institutions, as all of the material in Bio 5A is taught at *thousands* of other schools and in many free online courses, with many free tutorials, quizzes, tests, videos, etc.

52. "Can you sort the exam questions by topic, instead of how you have provided them?"

    Overall it is best that students see actual exams, as if they are used properly, they are the best way for a student to understand what a real exam experience will be like. Besides, students can easily see whether a particular question is from a topic like 'photosynthesis' or 'monohybrid crosses' and even search within Acrobat to find questions on a particular topic. Some questions and/or the answers will bring in concepts from multiple parts of the course, and cannot be assigned to only one lecture topic.

53. "How are the exams graded?"

Currently, forms are graded using an iNSIGHT 4 optical scanner manufactured by Scantron. Dr. Maduro oversees the grading process and inspects all forms flagged by the software that indicate multiple marks or faint marks. Care is taken to assure complete grading accuracy. From several thousand exams graded using this machine, Dr. Maduro has found that the accuracy rate is 100%. Apparent discrepancies are always explained by students having marked no answer, multiple answers, or an answer that differs from the one that they noted on their exam copy. This is why students are advised to check their answer forms carefully.

54. "Why aren't there free-response or short-answer questions on exams? I do better with partial credit."

    What ultimately matters for the final grade is a student's standing *relative to the rest of the class*. Students may feel that they do better on free-response questions, but then *so does the rest of the class*, so their *relative* scores will stay the same. The reason everyone does better on such exams is that everyone gets some form of part marks, so instead of scores being spread out over 20%-95%+ as with a multiple-choice exam, scores may get spread out from 40%-100%. But the relative ranking of every student does not change. If a student was the top student, they stay that way no matter what type of exam they are given. If they were just above average, they will still be just above average. Besides, in Bio 5A, short-answer questions have been used many times for Discussion quizzes, and the average scores on these tend to be between 4/10 and 5/10, which suggests that free-response questions in Bio 5A do *not* produce higher average scores. Even in upper-division classes, Dr. Maduro has given free-response exams and has obtained similar results as when he uses all multiple-choice exams.

    Many practical issues have made it difficult to work with free-response exams. First, there is not enough TA support to be able to grade exams containing a significant amount of free-response questions for hundreds of students, though you may see short answer questions in Discussion quizzes. Second, cheating (e.g. copying during an exam, or altering of answers later for increased credit) is an ongoing problem and consumes too much time to police. Third, it has been difficult to assure consistency in grading, and there tend to be a lot of grades questioned after-the-fact which consumes even more time, especially in a large class. Fourth, it is more difficult to sample across a wide range of topics the way multiple choice can. Fifth, students can sometimes completely misinterpret free-response questions. Multiple-choice allows channeling of responses to a restricted set of possibilities. Last, many free-response questions can be turned into sets of multiple-choice questions, giving students the opportunity for part marks. While making multiple choice exams increases work for the instructor(s), given the reduced work involved in grading such exams, students can often expect to be able to see their posted grade for an exam within a much shorter time, sometimes even the same day.

    Unfortunately, because the exams in Bio 5A are multiple-choice, many students assume that they need to only "recognize" correct answers. They therefore study superficially and try to memorize the answers to past exam questions. As noted many times in this document, this is just not an effective strategy for learning complex new material, and students are likely to get a 'C' or lower with this strategy.

55. "Multiple-choice tests are basically a guessing game. Students that do well are just lucky."

    That is just not true. Students that get an 'A' in Biol 5A generally have A's in other science classes, and conversely, students that get a poor grade in Biol 5A usually have poor grades in other science courses. This includes subjects like Chemistry, Mathematics and Physics, which use different assessment methods than Biol 5A. This means that the strategies that earn students A's in *any* science class generally apply to Biol 5A as well: It is *not at all* about luck. (By the way, these kinds of thinking patterns are self-destructive and are a sign of deeper character issues.)

    Besides, the odds are stacked against you. How lucky would a student have to be to get a lot of the questions right by guessing? If a multiple-choice test has 35 questions, the odds of getting at least 50% by guessing are about 1 in 30000, and of getting at least 80%, 1 in 25 trillion. Even if a student could correctly eliminate choices down to two alternates per question, the odds of getting at least 80% on a 35-question exam are still 1 in 4000. Of course, these probabilities are much lower on a test that has even more questions. Students can test their "luck" on the sample exams very easily to confirm that they are better off learning the material than counting on some kind of good fortune.

56. "I don't do well on the exams, but I understand everything going in. Therefore, my exam scores do not reflect my understanding nor do they test my knowledge."

    Only *some* of the test questions will directly assess knowledge of facts. Many questions will test *reasoning* skills and the ability to *apply* knowledge to new situations. A student could memorize all the words in the lecture notes, but that will not result in a high exam performance by itself: The concepts have to be *learned* and *understood*. Instructors give exams to measure learning, and they use the performance on those exams

to generate the final letter grades. This will not change any time soon, so students must get used to the idea that their grades, and hence their future career prospects, will be determined primarily by their performance on exams. Students who are having difficulty are advised to seek out the many resources available to them at UCR, such as the Academic Resource Center. If students have anxiety about taking the exams, they can practice taking the old exams under the same conditions as a real exam. They can form study groups. They can meet with the professor regularly to reinforce their learning. There are lots of resources available, but it is up to the students to use them.

57. "I did poorly on the midterm and I just don't get any of the concepts. I give up."

    Students are also in University to learn *how* to learn. If they are struggling, they have to identify their problems and get motivated to overcome them if they want success in college and in life. See the question above and the question "How can a student do well in Bio 5A?".

    Many Biology students want to become Doctors, Pharmacists, etc. These schools demand *high* GPAs. Deciding now to be an A student is the first step toward becoming motivated to make these dreams reality. See this link and read the part that says "There is no substitute for high grades."

58. "Why are many of the courses in the Bio 5 series taught by two professors instead of one?"

    Bio 5 courses are sometimes taught by a single instructor, but they are more often "team-taught" because: (a) Some department teaching loads are something like 1.5 courses per year, and the only way to teach half a course is to team-teach; (b) For Bio 5A, some faculty may be most comfortable with teaching only the first part (chemistry, biochemistry, cell biology) or the second part (molecular biology, genetics), with similar arguments for Bio 5B or Bio 5C; (c) The Bio 5 courses have a high enrollment, usually hundreds of students per section during the regular academic year, so it is considered an effective way to distribute the workload; (d) Some faculty may not be able to be on campus consistently for a particular quarter, and teaming up allows them to cover the class; (e) Team teaching is a good way to train a more junior (younger) professor in how to handle a large introductory undergraduate course, because the more senior (experienced) professor can provide ongoing advice during the junior person's time. We do appreciate that from the student perspective, it is usually preferable to have only one instructor.

59. "You should read some of the comments about you on RateMyProfessors.com."

    The University Administration does not look at these types of sites, so there is no point for your Professors to read them. Besides, during week 10, the instructor(s) and TAs are formally evaluated online (ieval.ucr.edu). (The first instructor in a team-taught course can elect to be evaluated in the middle of the quarter.) Instructors and TAs will not see any of the reviews from ieval.ucr.edu until after the final grades have been submitted, and unless the comments somehow identify the student, they remain anonymous even then. So there is an official way for students to express their comments*.

    While over time, sites like 'ratemyprofessors.com' seem to be used less and less (particularly if a professor already has dozens of comments), some students have come to see these sites as a kind of Yelp.com for their courses. They are free to anonymously post anything they wish, even if they did not take the course.

    While some of the comments on both ratemyprofessors.com and on ieval.ucr.edu are constructive, many can be quite nasty. These seem to be from students who experienced a one-time offense of some sort, such as a professor that told them they did not understand something, asked them to turn their computer off, or to be quiet in class; Or they could be from students that did poorly in the course, looking for a way to take some sort of "revenge" by rating the professor with low scores and vile comments. These types of comments are more likely to occur in big introductory courses like Biology 5A, because there are hundreds of students in a class, and many of them arrive to a university feeling entitled to earn a high grade – but they are completely unprepared for the workload and need someone else to blame. The easiest person to blame is the professor, because the professor is responsible for making the tests and assigning the grades. Usually these types of students will pick on whatever they can think of – the professor was hard to understand, spoke at too high a level, spoke at too low a level, wrote unclearly, wrote too many notes, didn't write on the board at all, used iLearn too much, didn't use it enough, spoke too fast, spoke too slow, was arrogant, was too nice, spoke too loud, spoke too soft, was unhelpful, was unapproachable, didn't tell enough jokes, told too many jokes, started class late, started class too early, got angry at students easily, was not stern enough, was not clear, kept repeating themselves, used too few clicker questions, used too many clicker questions, had too high expectations, had too low expectations, etc. While some of these may be true depending on a student's point of view, many are really just expression of a student's preference. Over their academic careers any one student will encounter *many* teachers for which at least some of these comments will apply – it is simply the nature of human beings that they be different, even those who have chosen to become University

Professors. The whole point is that students are supposed to take responsibility for their own education at a University, and that those who cannot, will look for someone else to blame, and there is *always* something negative that can be said about *anyone*.

With all the negative things that do get posted, it should come as no surprise that many professors do not read the written comments in their instructor evaluations and most will not bother with ratemyprofessors.com. Negative comments, particularly generic statements like "I hated the prof" and "worst professor I have ever had" are not particularly informative and they make the students look immature. Professors are not a business like a caterer or Best Buy; they are not competing for students, and their income derives primarily from their research achievements, so students' negative comments will likely not do the professors any harm with respect to the University. Some Professors will take constructive criticism to heart and make changes to how they do things, but after several years of teaching, most accept that there will always be the same types of criticisms in the comments, so they settle into a routine of teaching the same way for the rest of their careers. Occasionally, some professors that are found to be particularly ineffective (and this usually comes not from the review comments, but from colleagues in team-taught courses) may just be assigned to other courses.

If you had a positive experience, let the Professor know another way. Because many professors will not read the comments, if a student has positive things to say about their experience in a course, they might wish to tell the professors by email, or a greeting card, instead of writing them in the evaluations. Indeed, your instructors might like to know who you are and it is uplifting for professors to hear positive comments of any type.

*As with anything electronic these days, students should be cautioned that if they post something in the evaluations that suggests an instructor did something illegal or amoral, the administration can identify the student because it was their login used to post the comments. If such a comment is found to be a false accusation, the student could face *severe* penalties.

60. "With all of these unreasonably high expectations, you are just setting me up to fail."

    No, by telling you these expectations up front and how to do well, we are setting you up to *succeed*. Like it or not, our expectations are similar to those of other universities. And just as at those other institutions, it is up to the students to live up to those expectations.

61. TL;DR

    "All of this is too much to read or do. Give me the real secret to doing well."

    There is no shortcut. The secret to doing well is not a secret at all: You have to work very hard – probably *much* harder than you worked in high school. It is all up to you to use the resources at your disposal, and to use them effectively.